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GB A 2105517 GB A 2002522 GB 1520889

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H1M

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(54) Switch/display units

(57) A switch/display unit comprises a dot matrix electro-luminescent display, having two sets of parallel elongate electrodes (11), (14), one set being inclined to the other, these sets being applied to opposite sides of a layer of phosphor (13). A transparent dielectric panel (10) is superimposed in front of the electro-luminescent display, so that the first set of electrodes (11), which are formed from a transparent conductive material, abut the rear surface of the dielectric panel (10). A transparent conductive layer (12) is formed in front of the dielectric panel, so that it will capacitively couple electrodes of the first set of electrodes (11) with other electrodes of the first set of electrodes (11) or other electrodes on the rear surface of the dielectric panel. This capacitive coupling may be varied by touching or moving the conductive layer (12). By applying read pulses to one of the sets of electrodes that are capacitively coupled via the conductive coating and sensing the pulses transmitted to the other electrodes, actuation of the switch can be detected. Means is also provided to apply ignition pulses to the first and second sets of the elongate electrodes (11), (14), so as to provide an electro-luminescent display which may change in response to actuation of the switch. Several such switch/display units may be combined into an array, utilising a common dielectric panel and other components.

FIG.1.

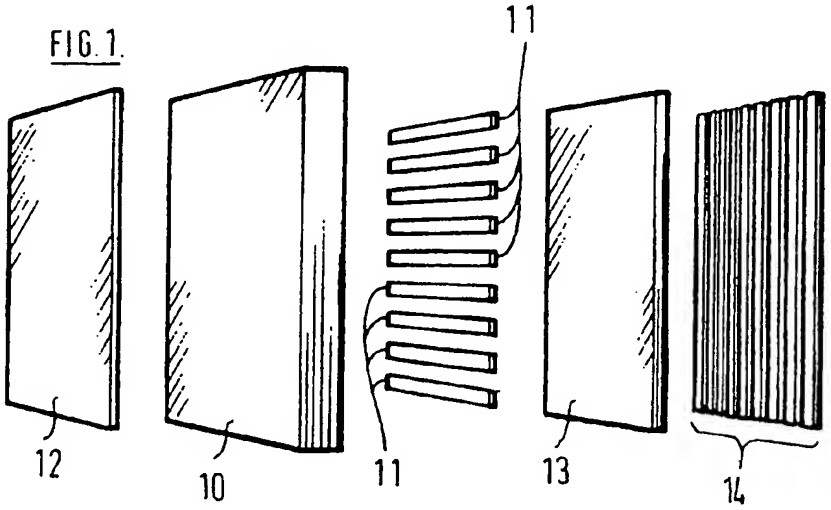

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FIG.1.

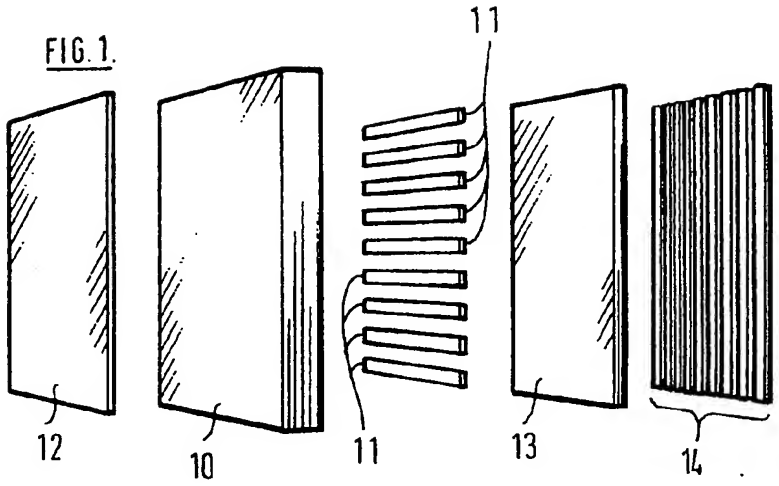

FIG.2.

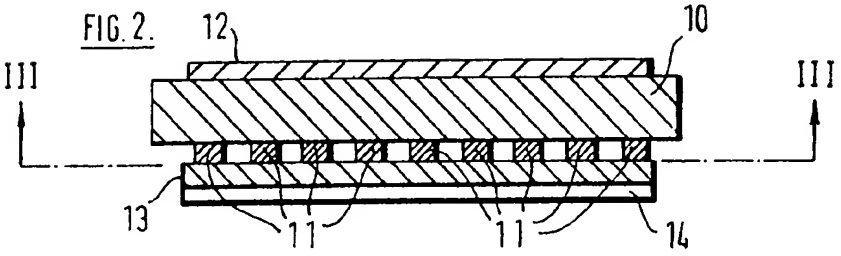

FIG.3.

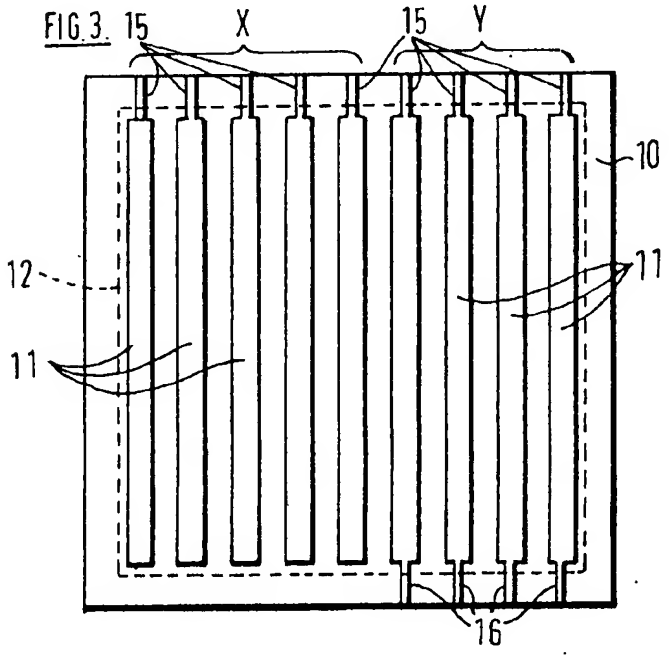

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FIG4.

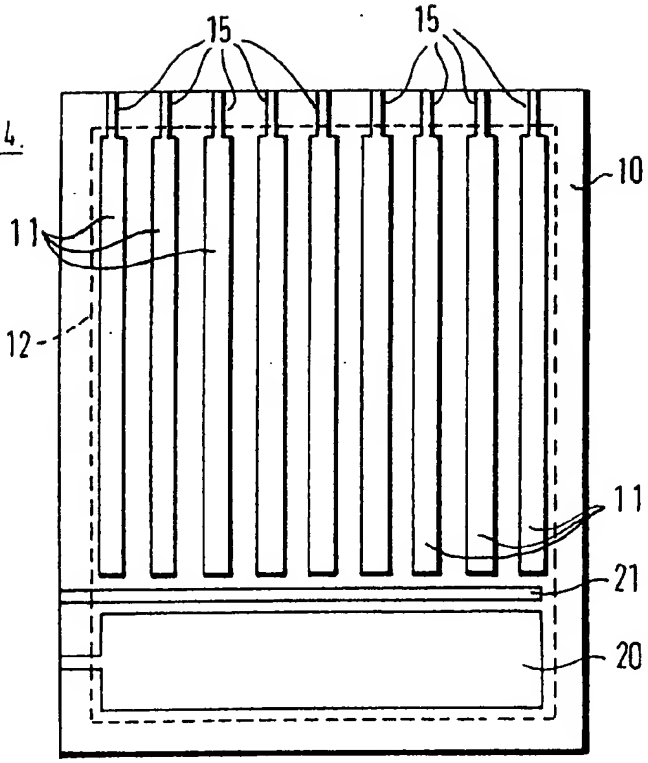

FIG.8.

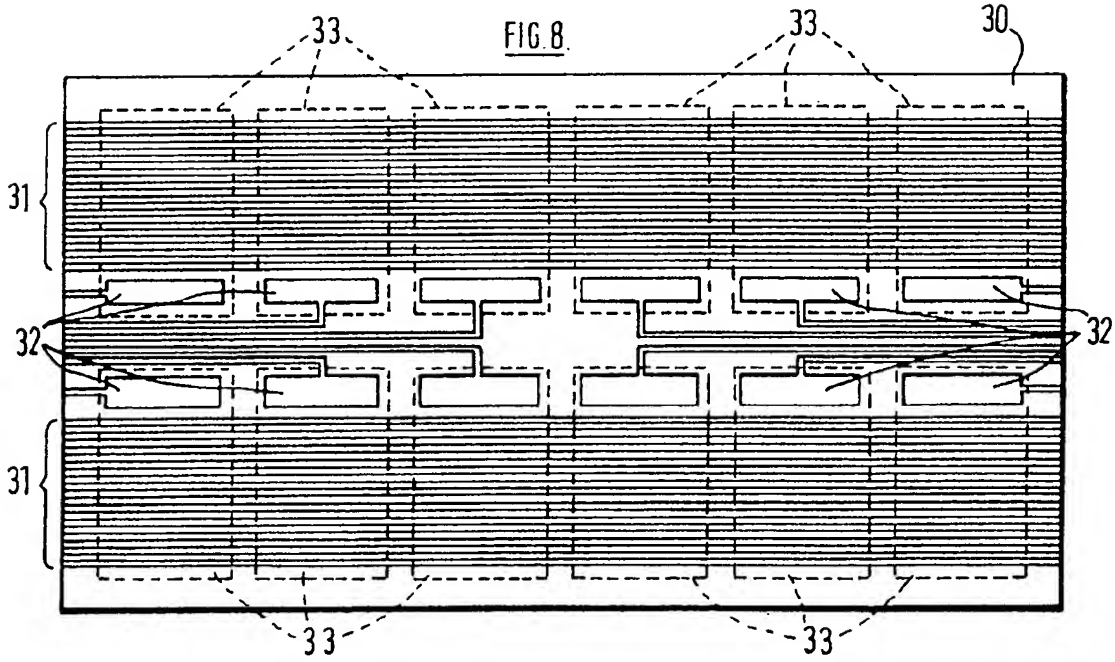

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FIG.5.

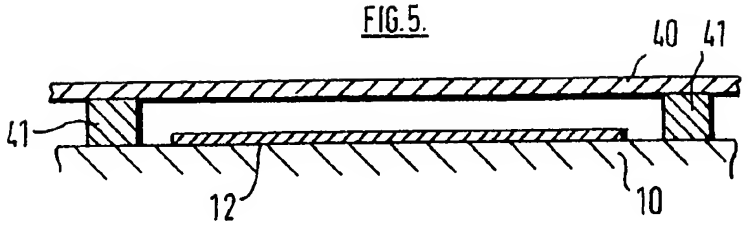
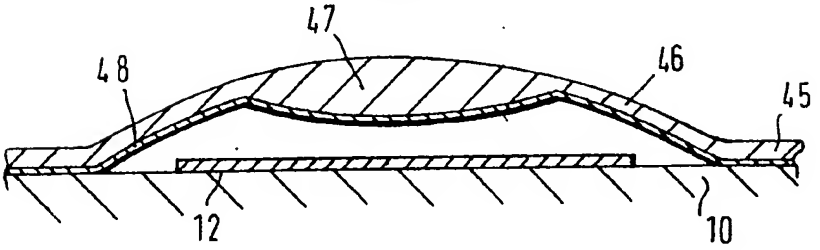


FIG.6.



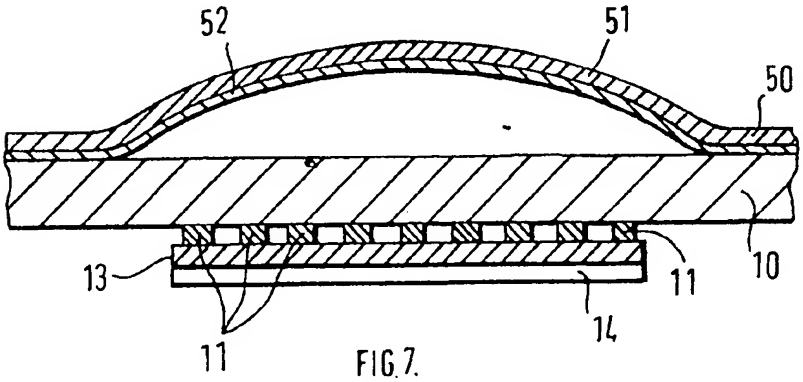


FIG.7.

SPECIFICATION

Swit h/display units

The present invention relates to switch/display units.

British Patant Specification No 2002522 discloses a touch switch with integral electroluminescent display. This switch may be arranged so that the switch, or a legend on the switch, is illuminated upon actuation of the switch. The illuminated area of the switch is defined by an insulating mask which controls the area of excitation of a layer of phosphor. The area that may be illuminated would therefore be fixed when the switch is manufactured and the switch is consequently suitable to control only one function. The present invention provides a switch/display unit in which the display may be varied electronically, thus providing a programmable multi-function switch.

According to one aspect of the present invention, a switch/display unit comprises; a transparent dielectric panel; a first set of elongate parallel electrodes formed from transparent conductive material on the rear surface of said dielectric panel; a layer of phosphor in contact with said first set of electrodes; a second set of parallel elongate electrodes mounted in contact with the rear surface of the layer of phosphor, the second set of electrodes being inclined to the first set of electrodes, so that the electrodes of one set overlap those of the other set to form a dot matrix; and a transparent conductive layer formed in front of the dielectric panel and overlying the first set of electrodes.

The conductive layer in front of the dielectric panel may be formed on the front surface of the panel. With this form of construction, the conductive layer will capacitively couple the electrodes on the rear surface of the panel. This capacitive coupling may be modified by applying an electrical load to the conductive layer by, for example, touching or earthing the conductive layer, and this change in coupling may be used to produce a signal for switching purposes. Alternatively, the conductive layer may be spaced from the front surface of the dielectric panel, but arranged so that it may be moved into engagement with the panel. With this arrangement, initially electrodes on the rear surface of the panel will not be coupled capacitively to any great extent, but will be coupled when the conductive layer is moved into contact with the panel. Again this change in coupling may be used to produce a signal for switching purposes.

For switching purposes, the first set of electrodes may be divided into two groups. Read pulses may be applied to one of these groups of electrodes by means of suitable circuitry. The other group of electrodes may be connected to circuity capable of sensing the change in signal on this group of electrod s, due to the change in capacitive coupling between the groups of electrodes when the switch is actuated, and initiating a switching action in respect to that change. Alternatively, additional electrodes may be provided on the rear surface of the dielectric panel to take over the function of one or the other of the groups of electrodes, so that for example read pulses may be applied to the whole set of electrodes on the rear face of the dielectric panel and a separate electrode may be used for sensing purposes.

For illumination purposes, pulses of one polarity are applied to one or more of the electrodes of the first set of electrodes and pulses of opposite polarity are applied to one or more of the electrodes in the second set of electrodes. Where a pulsed electrode of the first set overlies a pulsed electrode of the second set, a potential is applied across the intermediate layer of phosphor sufficient to excite the phosphor and cause illumination at that point. The required symbol or legend may thus be built up from illuminated dots, by pulsing the appropriate electrodes in each set of electrodes. Typically the first and second sets of elongate electrodes may contain between 20 and 40 electrodes per centimetre.

The read pulses that are applied to the electrodes for switching purposes, may typically be as low as 10 volts and may be of either polarity. It is however convenient to use the same circuitry for applying the read pulses and the illumination control pulses to the set of the electrodes on the rear face of the dielectric panel. The read pulses are applied at intervals between illumination pulses. For example, the minimum potential difference required to cause the phosphor layer to luminesce is, typically from 80 to 120 volts. Illumination pulses of from + 40 to + 60 volts are consequently applied to the appropriate electrodes of one set of electrodes and pulses of from − 40 to − 60 volts applied to the appropriate electrodes of the other set of electrodes. These pulses would typically be of 10 to 30 microsecond duration at a frequency of from 0.5 to 2 kHz. Read pulses of the same amplitude as the illumination pulses (i.e. ± 40 to ± 60 volts) would be applied to all the electrodes of the first set of electrodes or group of the first set of electrodes, between the illumination pulses. These pulses would typically be of 10 microsecond duration at a frequency of 500 Hz.

Various embodiments of the invention are now described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates diagrammatrically in exploded view, a switch/display unit formed in accordance with the present invention;

Figure 2 shows a sectional side elevation of the switch/display unit illustrated in Figure 1;

Figure 3 shows a sectional view along the line III-III shown in Figure 2;

Figure 4 shows a view similar to that shown in Figure 3, illustrating a modified switch/display unit;

Figures 5 and 6 illustrate diagrammatically in sectional side elevation, modifications to the switch/display units illustrated in Figures 1 to 4;

Figure 7 illustrates diagrammatically in sectional side elevation a further form of switch/-display unit formed in accordance with the present invention; and

Figure 8 shows a similar view to that shown in Figures 3 and 4, illustrating a 2 × 6 array of switch/display units formed in accordance with the present invention.

The switch/display unit illustrated in Figures 1 to 3 comprises a panel 10 made of transparent dielectric material, for example glass. A set of transparent elongate parallel electrodes 11, made from electrically conductive material such as tin oxide, are applied to the rear surface of the panel 10. A transparent layer 12 of conductive material is applied to the front surface of panel 10, so that it overlies the set of electrodes 11 on the rear surface of the panel 10.

A layer of phosphor 13 is applied to the rear of the set of electrodes 11 and a second set of elongate parallel electrodes 14, are applied to the rear surface of the phosphor layer 13. The second set of electrodes 14 are arranged so that they extend at right angles to the first set of electrodes 11, each electrode of one set thus overlapping all the electrodes of the other set, to form a dot matrix.

As illustrated in Figure 3, electrodes 11 are provided with input connections 15 which may be connected to circuitry suitable for applying a voltage pulse individually to each electrode. Electrodes 14 are provided with similar input connections (not shown) by which they may be connected to circuitry for applying a voltage pulse of opposite polarity to those applied to electrodes 11, individually to each electrode 14. Typically, the phosphor layer used will have an illumination threshold of from 80 to 120 volts and the voltage pulse applied to electrodes 11 may be from 40 to 60 volts while the pulses applied to electrodes 14 may be from −40 to −60 volts.

If pulses are applied to one electrode in each of the sets 11 and 14, a potential of from 80 to 120 volts will be applied across the layer 13 of phosphor, at the point where those electrodes 11 and 14 overlap. This potential will excite that portion of the phosphor layer 13 and produce an illuminated dot. By applying pulses simultaneously to the appropriate electrodes in each set of electrodes 11 and 14, th plurality of dots may be illuminated to form a legend or symbol. The legend or symbol may be altered by applying pulses to different electrodes in the sets 11 and 14. Typically, these illumination pulses will have a duration of from 10 to 30 microseconds and be applied to the electrodes at a frequency of 0.5 to 2 kHz, while the display is illuminated.

To provide switch means the set of electrodes 11 are divided into two groups X and Y, as shown in Figure 3. The group Y is provided with a set of output connections 16 by which they may be connected to suitable sensing circuitry. Read pulses may now be applied simultaneously to all the electrodes 11 in group X and these will be coupled capacitively, via the conductive layer 12, to the electrodes 11 in group Y and an output pulse will consequently be transmitted to the electrodes 11 in group Y. This output pulse may be detected by the sensing circuit. To actuate the switch, an electrical load is applied to the conductive layer 12 by, for example, a person touching the conductive layer 12. This load will reduce the capacitive coupling between groups X and Y of the set of electrodes 11 and will thus reduce the signal on the electrodes 11 in group Y. This reduction in signal may be detected by the sensing circuit and used to effect switching.

For convenience, the circuitry to apply illumination pulses to electrodes 11, may also be used to apply the read pulses, but instead of pulsing individual electrodes 11 as required for illumination purposes, it will be arranged to pulse all the electrodes 11 in group X simultaneously. These read pulses will be applied in between the illumination pulses and will typically be of the order of 10 microsecond duration at a frequency of 500 Hz. As no pulse will be applied to the electrodes 14 when the read pulses are applied to the electrodes 11, the potential across the phosphor layer will not reach the illumination threshold and consequently the display will not be affected.

The switch/display unit described above provides a display which may be varied as desired. The switch may consequently be used as a programmable multi-functional switch, the display being arranged to change in response to actuation of the switch or in response to actuation of other switches in, for example, an array of similar switch/display units.

Instead of dividing the set of electrodes 11 into two groups X and Y as described above, an additional electrode 20 may be provided on the rear surface of panel 10 as illustrated in Figure 4. The phosphor layer 13 and second set of parallel electrodes 14 are applied to the rear of the first set of electrodes 11 and the display is operated in the manner described above.

However, for switching purposes, read pulses are applied simultaneously to all the electrodes 11 in the set. The conductive layer 12 is extend d, so that it overlies both the set

of I ctrodes 11 and the electrode 20 and this couples the electrodes 11 to the electrode 20. Electrode 20 is connected to a suitable sensing circuit, so that the change in signal, when a load is applied to the conductive layer 12, can be detected and switching initiated as described above. A further guard electrode 21 is provided on the rear surface of panel 10 between the set of electrodes 11 and electrode 20. This guard electrode 21 is connected to earth so as to minimise direct coupling of the electrodes 11 with electrode 20.

The switch/display units described above may be modified as illustrated in Figure 5, by positioning a transparent, resilient conductive membrane 40 in front of the conductive layer 12, said membrane 40 being spaced from the conductive layer 12 by means of insulative spacers 41. This modified switch/display unit is actuated by a person depressing the membrane 40 until it comes into contact with the conductive layer 12. The conductive layer 12 will then be connected to earth through the membrane 40 and the person touching the membrane, and the resulting electrical load on the conductive layer 12 will cause a reduction in the capacitive coupling of the switch, in the manner described above. The movement of the membrane 40 will provide a tactile feedback to the person operating the switch. The membrane 40 may be moulded to form a bubble or blister formation over the conductive layer 12, so that when depressed it will move into engagement with the conductive layer with a snap action feel. These bubble or blister formations may also serve to separate the membrane 40 from the conductive layer 12, in place of the spacers 41.

In the switch illustrated in Figure 6, a membrane 45 is formed from transparent non-conductive resilient plastics material, and is moulded to provide a bubble or blister formation 46 which overlies and is separated from the conductive layer 12. The inner surface of the membrane 45 is provided with a transparent conductive coating 48, this coating 48 being connected to earth. When this switch is actuated by depressing the blister formation 46, the conductive layer 12 is connected directly to earth via coating 48. The resulting change in capacitance will consequently be independent of the person actuating the switch and will give a more consistent change in signal when the switch is actuated. Furthermore. this form of switch may be actuated by nonconductive implements.

When pressure is removed from the blister formation 46 it will snap back away from the conductive layer 12, so that the capacitive characteristics of the switch will revert to their original values when the switch is not actuated.

The central portion of the blister formation 46 may be formed with a lens 47, through which the display will be magnified.

In the switch/display unit illustrated in Figure 7, the arrangement of the sets of electrodes 11 and 14 and phosphor layer 13, on the rear of the dielectric panel 10, is the same as that disclosed with reference to Figures 1 to 3. However, instead of forming a conductive layer 12 on the front surface of the panel 10, a conductive coating 52 is provided on the rear surface of a blister formation 51 formed in a transparent, resilient non-conductive membrane 50 positioned in front of the panel 10 so that it overlies the set of electrodes 11 and is spaced from the front surface of panel 10. The conductive layer 52 is electrically isolated. With this construction, there will be little or no coupling between the groups X and Y of electrodes 11 when the switch is in its non-actuated condition. Consequently when read pulses are applied to electrodes 11 in group X, there will be no or only a very small output pulse on the electrodes 11 in group Y. However, when the blister formation 51 is depressed so that the coating 52 engages the upper surface of panel 10, the electrodes 11 in groups X and Y will be coupled capacitively through the coating 52. A read pulse applied to the electrodes 11 in group X will now produce an output pulse of significant amplitude on the electrodes 11 in group Y and this pulse may be used to initiate switching.

This form of switch, in which the conductive layer 52 is spaced from the front surface of the dielectric panel 10, may be used with other arrangements of electrodes on the rear surface of the dielectric panel 10, for example, in the form described with reference to Figure 4.

The switches described above may be used individually or several such switches may be used together. However, this form of construction is suitable for producing an array of switch/display units on a single panel, as illustrated in Figure 8. This figure shows a 2 by 6 array of switch/display units, two rows of six switch/display units being formed on a dielectric panel 30. Two sets of transparent elongate electrodes 31 are provided on the rear face of the panel 30. Two rows of six separate transparent electrodes 32 are also formed on the rear face of the panel 30, between the sets of the electrodes 31. Each set of electrodes 31 is capacitively coupled to the adjacent row of electrodes 32 by means of individual transparent conductive layers 33 formed on the front surface of panel 30. Each conductive layer 33 overlies a different one of the electrodes 32 and a portion of the adjacent set of electrodes 31. As described above, the two sets of electrodes 31 may be connected to circuitry for applying read pulses, while the electrodes 32 may be connected to suitable sensing circuitry. The application of an electrical load to one of the conductive layers 33 will alter the coupling between the

set of electrodes 31 and electrode 32 covered by that conductive layer 33 and the change in signal on the electrode 32 can be sensed to effect a switching action appropriate to that switch.

A phosphor layer is applied to the rear surface of the electrodes 31 and 32 and two further sets of parallel elongate electrodes are applied to the rear face of the phosphor layer, in the manner described above. The display means of each switch can thus be controlled by applying pulses to the appropriate electrodes on either side of the phosphor layer, as described with reference to the individual switch/display units.

Similarly, switches of the form described with reference to Figure 7 may be formed into an array.

The switch/display units of such arrays may be provided with resilient membranes in the manners described with reference to Figures 5 to 7. In such arrays the membranes for each switch will preferably be formed as a single sheet, for example as a sheet moulded with individual blister formations 46 or 51 for each switch. Where the membrane has a conductive coating, as described with reference to Figures 6 and 7, this too may be formed as a single coating over the whole of the sheet.

Various modifications may be made without departing from the invention. For example, with the array of switch/display units, the two sets of electrodes 31 on the rear surface of the panel 30 may alternatively be arranged vertically in the manner indicated in Figure 4. With arrays of switch/display units of the type described above, the units may be multiplexed under the control of a microprocessor, as described in British Patent No 2059657.

Finally, it should be noted that the accompanying drawings are diagrammatic illustrations only. They are not intended to indicate the relative dimensions and particularly thicknesses of the components. Typically the dielectric panel 10 will be of the order of 3mm thick; the phosphor layer 13 of the order of 40 microns thick; and the various electrodes 11, 14, 20, 21, 31, 32 and conductive layers 12, 33 of the order of 0.05 microns thick.

CLAIMS

1. A switch/display unit comprising; a transparent dielectric panel; a first set of elongate parallel electrodes formed from transparent conductive material on the rear side of said dielectric panel; a layer of phosphor in contact with said first set of electrodes; a second set of parallel elongate electrodes mount d in contact with the rear surface of the layer of phosphor, the second set of electrodes being inclined to the first set of lectrodes, so that the electrodes of one set overlap those of the other s t to form a dot matrix; and a transparent conductiv layer formed in front of the dielectric panel and overlying the first set of electrodes.

2. A switch/display unit as claimed in Claim 1 in which the first set of electrodes are divided into two groups, one group of read electrodes adapted to be connected to means for applying read pulses thereto and the other group of sense electrodes adapted to be connected to means for sensing pulses thereon.

3. A switch/display unit as claimed in Claim 1 in which the first set of electrodes is adapted to be connected to means for applying read pulses thereto and one or more additional transparent electrodes are formed on the rear surface of the dielectric panel which lies under the transparent conductive layer, said additional electrodes being adapted to be connected to means for sensing pulses thereon.

4. A switch/display unit as claimed in any one of Claims 1 to 3 in which the electrodes adapted to be connected to means for applying a read pulse thereto are separated from those adapted to be connected to means for sensing pulses, by means of a guard electrode which is adapted to be connected to earth.

5. A switch/display unit as claimed in any one of Claims 1 to 4 in which the transparent conductive layer is provided on the front surface of the dielectric panel.

6. A switch/display unit as claimed in Claim 5 in which a transparent resilient conductive membrane overlies the conductive layer and is spaced therefrom.

7. A switch/display unit as claimed in Claim 6 in which a transparent resilient nonconductive membrane overlies the conductive layer and is spaced therefrom, said membrane having a transparent conductive coating on the surface thereof adjacent to the conductive layer.

8. A switch/display unit as claimed in any one of Claims 1 to 4 in which the transparent conductive layer is spaced from the front surface of the dielectric panel and is moveable into contact therewith.

9. A switch/display unit as claimed in Claim 8 in which the transparent conductive layer is formed on the rear surface on a transparent conductive resilient membrane which overlies and is separated from the dielectric panel.

10. An array of switch/display units formed in accordance with any one of Claims 1 to 9, utilising a common dielectric panel.

11. An array of switch/display units as claimed in Claim 10 in which a first set of elongate electrodes are common to a plurality of the switch/display units.

12. A switch/display assembly as claimed in any one of the preceding claims including means for applying illumination pulses individually to each electrode in the first set of electrodes and each electrod in the second set of electrodes; means for applying r ad

puls s to a group of the first set of electrodes; and means for sensing pulses transmitt d capacitively via the conductive layer to on or more other electrodes on the rear surface of the dielectric panel.

13. A switch/display assembly as claimed in Claim 12 in which the means for applying illumination pulses individually to each electrode in the first set of electrodes also serves to apply read pulses simultaneously to a group of those electrodes.

14. A switch/display assembly substantially as disclosed herein, with reference to and as shown in Figures 1 to 3, 4, 5, 6, 7 and 8 of the accompanying drawings.

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